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QUARTERLY PROGRESS REPORT 3

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ELECTROMAGNETIC DEEP-PROBING (100-1000 KMS)

OF THE EARTH'S INTERIOR FROM ARTIFICIAL SATELLITES:

CONSTRAINTS ON THE REGIONAL EMPLACEMENT OF CRUSTAL RESOURCES

NAS 5-26138

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Statement of Work

Objective

The objective of this investigation is to evaluate the applicability of electromagnetic deep-sounding experiments using natural sources in the magnetosphere by incorporating Magsat data with other geophysical data.

Approach

The investigator shall pursue the above objective through an analysis of Magsat satellite data, ground-based magnetic observations, appropriate reference field models, and other satellite data.

The objective will be pursued by seeking the optimal combination of observations which lead first to a global, and then to a regional, characterization of the conductivity of the Earth's upper mantle.

Tasks

The following tasks shall be performed by the investigator in fulfillment of the above objective:

    a. Use data from Magsat satellite to constrain a long-period global "response function" for the average Earth at low latitudes over a period ranging from 6 hours to 27 days.

    b. Synchronize the Magsat data with low-latitude ground-based observatory data to determine the vertical gradient of the respective magnetic field components. Use the vertical gradient of the appropriate components to independently ascertain the separation of external and internal field contributions.

    c. Segregate the Magsat electromagnetic "response functions" according to the tectonic regime at the Earth's surface and evaluate systematic differences between regions having lateral scale sizes on the order of 1000 km or greater.

    d. Theoretically evaluate problems of resolution and interpretation involving electromagnetic induction by temporally and spatially-varying magnetospheric sources in a rotating inhomogeneous Earth as observed at arbitrary points in space. Use these theoretical studies to constrain the interpretation of Magsat data as well as to propose further applications of satellite-based electromagnetic deep-sounding experiments.

    e. Integrate the regional response functions with other geophysical data in order to constrain the joint interpretation of comprehensive physical models.

    f. Prepare and submit to NASA periodic progress reports and a detailed final report documenting the results of this investigation.

I) <u>Interactions of External Source Fields With An Earth Having Finite Conductivity</u>. We are continuing to develop our computer program for looking at the coupling of finite-dimensioned source fields with a laterally heterogeneous earth (see Quarterly Report I).

II) <u>Considerations In Noise-Free Estimates of Global Electromagnetic Response Functions Using Satellite Data</u>. We are continuing to develop an algorithm for calculating a time-varying reference field using ground-based magnetic observatory data (see Quarterly Report II).

<u>Miscellaneous</u>

One abstract has been submitted to the AGU meeting in May 1981 (attached) and another abstract has been submitted to the IAGA meeting in August 1981 (attached). Work for the next quarter will be oriented toward these topics.

ARE THERE INDUCTION EFFECTS IN Dst CORRECTIONS TO MAGSAT DATA?

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There is a need, when deriving residual
field models from MAGSAT data, to be able to
apply corrections to the data for the con-
tribution from Dst. Unfortunately induction
effects in Dst preclude in general the simple
correction of the observed field by subtracting
the Dst-term; one needs to account for the in-
duced phase-shifted internal component. In
addition, the temporal behavior of Dst is such
that a magnetic storm with a sudden commence-
ment has higher frequency energy at early
storm-time (T<2 days) and lower frequency
energy at late storm-time (2<T<5 days). The
result is that the ratio of internal to exter-
nal fields is not a simple constant, but the
amplitude of the ratio changes with time during
a magnetic disturbance. Fortunately, simple
model calculations indicate that during late
storm-time the internal:external field ratio
is essentially constant so that there is hope
that quantitative correction factors can be
applied to late storm-times in a straight-
forward way. As one attempts such a correction
during earlier storm-time, the morphology of
the Dst event has to be taken into account.

ELECTROMAGNETIC INDUCTION AND SOURCE FIELD EFFECTS IN MAGSAT DATA

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It is advantageous when compiling regional magnetic charts to be able to use satellite data during periods when the magnetic field is modestly to severely disturbed. It is necessary, therefore, to develop algorithms to compensate observed field data for the effects of time varying magnetic sources of external origin, particularly accounting for possible induction effects in the earth.

To illustrate some of the complications in such a procedure, a series of theoretical models is presented to illustrate the effects of external source fields coupling to an earth having a finite conductivity. Among the cases considered are:

1) Induction effects in the Dst index such that a storm-time dependent correction factor need be applied.

2) The electromagnetic coupling of ionospheric current systems to both a homogeneous earth having finite conductivity, and to an earth having gross lateral variations in its conductivity structure, e.g. the ocean-land interface.

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4. No special facilities

5. Oral